

REPORT
OF THE
DEPARTMENT OF THE NAVAL SERVICE
FOR THE
FISCAL YEAR ENDED MARCH 31, 1921

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OTTAWA
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PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1921

REPORT

DEPARTMENT OF THE NAVAL SERVICE

*To His Excellency the Duke of Devonshire, K.C., P.C., G.C.M.G., G.C.V.O., etc., etc.,
Governor General and Commander in Chief of the Dominion of Canada*

MAY IT PLEASE YOUR EXCELLENCY:

I have the honour to submit herewith for the information of Your Excellency and the Parliament of Canada, the Eleventh Annual Report of the Department of the Naval Service, being for the year ended March 31, 1921.

I have the honour to be,

Your Excellency's most obedient servant,

C. C. BALLANTYNE,
Minister of the Naval Service.

OTTAWA, ONT., July 2, 1921.

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REPORT

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DEPARTMENT OF THE NAVAL SERVICE

FOR THE

FISCAL YEAR ENDED MARCH 31, 1921

OTTAWA, July 1, 1921.

Honourable C. C. BALLANTYNE,
Minister of the Naval Service,
Ottawa, Ont.

SIR,—I have the honour to report on the Department of the Naval Service for the fiscal year ended March 31, 1921, under the following headings:—

1. Royal Canadian Navy.
2. Fisheries Protection Service.
3. Survey of Tides and Currents.
4. Life-Saving Service.
5. Hydrographic Survey.
6. Financial Statement.
7. Stores.
8. Radiotelegraph Service.
9. General.

I. ROYAL CANADIAN NAVY

ROYAL NAVAL COLLEGE OF CANADA

The Royal Naval College of Canada was established in 1910. Its object as defined by Act of Parliament is to impart education in naval science. The course at the Naval College, which covers a period of three years, includes theoretical and practical training in seamanship, navigation, engineering, mathematics, mechanics, physics and also the usual academic subjects.

Although the department does not guarantee naval commissions to cadets graduated from the college, it makes a limited number of appointments to the service from amongst them each year. These appointments depend upon the requirements of the service. On the other hand, cadets who are offered naval appointments are not obliged to accept. The only condition imposed upon graduated cadets is that they will join the Canadian Naval Reserve, should that force be organized.

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Cadets who do not join the Naval Service, and who desire to continue their education at one of the Canadian universities, are accepted by the Universities of McGill (Montreal), Toronto (Toronto), and Queen's (Kingston, Ont.), as second-year students in their science course. Cadets who do not wish to proceed with their studies, are quite well equipped, particularly in engineering, to make their way in life. The department gives preference to graduated cadets in recommending applicants for appointment to the Hydrographic Surveys.

Cadets are required to pay annually a tuition of one hundred dollars in advance. In addition to this amount they must deposit a further sum of four hundred and fifty dollars (\$450) for the first year and three hundred and twenty-five dollars (\$325) for each of the second and third years, to cover necessary expenses. Unexpended amounts from deposits are refunded to the parent or guardian. Should the expenses of any cadet exceed the deposit the parent or guardian is required to pay the difference.

An allowance for travelling expenses is made at the rate of four cents per mile for excess mileage above 500 necessarily travelled by cadets on first joining the college and for the last journey from the college at the completion of the three year course. No allowance is made for travelling to and from the college for vacations.

Vacations extend from the third week in June to the second week in September, with two weeks at Christmas and five days at Easter.

The progress, both physical and mental, of cadets, is reported upon as satisfactory during the past year. The general health at the college has also been excellent.

In June, 1920, fourteen cadets were successful at the passing out examinations. Four of these were given commissions.

The annual cadetship examinations were held by the Civil Service Commission in June, 1920. Fifteen candidates were successful and joined the Naval College in September of that year. There were forty-five cadets at the Naval College during the 1920-21 school year.

PERSONNEL

The reorganization of the Naval Service begun in March, 1920, was continued during the year 1920-21. All ranks and ratings not essential to the service, or who had not the necessary qualifications for retention, were demobilized. The civilian staff at headquarters was also reduced to a peace basis. Only a sufficient naval and civilian staff was retained to efficiently carry out the essential work of the department. The reduction of staffs became effective from the 15th May, 1920, but a small number of supernumerary naval men and civilians were retained for short periods thereafter to assist in carrying out necessary readjustments or to complete the work on hand. The reorganization was completed during the year.

There remained in the service one hundred and forty-three officers of all ranks, thirty-nine of whom are undergoing training in Imperial ships.

ROYAL CANADIAN NAVAL SHIPS

H.M.C. cruiser *Aurora* and two light destroyers H.M.C.S. *Patriot* and *Patrician*, which were presented to Canada by the Imperial Government, were transferred to Canadian authorities on the 1st November, 1920, and were placed in commission in the Royal Canadian Navy. The following vessels compose the Royal Canadian Squadron: H.M.C.S. *Aurora*, H.M.C.S. *Patriot*, H.M.C.S. *Patrician*, H.M.C. submarines *C.H. 14* and *C.H. 15* and *Depot*.

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H.M.C.S. Aurora.—The *Aurora* was built at Devonport Dockyard and was completed in 1914. It is a ship of 3,500 tons displacement with a length over all of 436 feet, beam 39 feet, mean draught 13½ feet, and maximum draught 15½ feet. She is fitted with Parsons turbines, eight Yarrow small tube boilers. She carries tripod masts and has a designed horse-power of 40,000. Her speed is 28.5 knots and she carries a complement of 325 officers and men. The estimated cost of construction of the *Aurora* was £289,000. The *Aurora* is commanded by Captain Henry G. H. Adams, C.B.E., R.N.

H.M.C.S. Aurora was attached to the General Imperial Fleet, 1914-17. It participated in the Scarborough raid on the 16th December, 1914, and in the action at Dogger Bank on the 24th January, 1915. It was the first to report the presence of the enemy and first in action. During 1918 the *Aurora* was on minelaying duties at Skagerrack and was one of the vessels comprising the outer patrol at the Zeebrugge Raid.

H.M.C.S. Patriot and *Patrician*.—These vessels were built by Messrs. Thornycroft and were completed in 1916. They have a displacement of 1,004 tons and their overall length is 271 feet and 274 feet, respectively. Their beam is 27½ feet and draught 10½ feet. They are fitted with Brown-Curtis turbines and three Yarrow boilers, and have a designed horse-power of 27,500, speed 35 knots, complement 74. The estimated cost of construction of these vessels was £105,000 each.

The *Patriot* is commanded by Lieutenant C. T. Beard, R.C.N., and the *Patrician* is commanded by Lieutenant G. C. Jones, R.C.N.

From 1916 until the close of the war the *Patriot* was engaged on various patrol duties and was attached to the General Imperial Fleet as was also the *Patrician*.

Movements.—On the 1st December, 1920, the *Aurora*, *Patriot* and *Patrician* were handed over to Canadian authorities at Plymouth. The following schedule shows their movements from that date up to the end of the fiscal year:—

Place	Arrived	Left
Plymouth..	December 1, 1920	December 1, 1920
Azores (Fayal)..	December 6, 1920	" 8, 1920
La Corraça Bay	" 15, 1920	" 18, 1920
Halifax..	" 21, 1920	January 8, 1921
Bermuda..	January 11, 1921	" 15, 1921
Trinidad..	" 20, 1921	February 2, 1921
Panama..	February 7, 1921	" 8, 1921
Corinto..	" 11, 1921	" 12, 1921
La Libertad..	" 13, 1921	" 15, 1921
San Jose..	" 15, 1921	" 17, 1921
Salina Cruz..	" 18, 1921	" 21, 1921
Manganello..	" 23, 1921	" 25, 1921
San Diego..	March 2, 1921	March 5, 1921
Esquimalt..	" 9, 1921	" 11, 1921
Vancouver..	" 11, 1921	" 16, 1921
Esquimalt..	" 16, 1921

During the journey from Plymouth to Bermuda range-finding exercises were carried out on all working days. The ships' complement also underwent training in the use of guns and firing exercises. Between Halifax and Trinidad similar training and exercises were taken. At Port of Spain H.M. ships *Calcutta* and *Constance* joined the Canadian squadron and joint operations and exercises were performed covering a period of one week.

A sports club and rifle club for the ratings have been established on board the ships of the Canadian squadron and have proved a source of valuable training to the ships' companies.

At various periods night-firing exercises and star shell and searchlight work have been performed.

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En route to Corinto special exercises in tactics were performed.

On the journey from Halifax to Esquimalt various official visits were made by the officers of the Canadian squadron.

During the long cruise from Plymouth to Esquimalt lengthy tests were carried out to ascertain what speed was most economical. Tests were also carried out for fuel by using commercial oil as well as Admiralty oil with a view to adopting for use the most economical and efficient.

The health of officers and men of H.M.C. ships is reported upon by commanding officers as excellent.

BOYS' TRAINING ESTABLISHMENT

During the latter part of 1920 action was taken to establish a boys' training school at Halifax, where boys entered for service in the Royal Canadian Navy may be properly trained. It is the intention to replace, as soon as possible, Imperial ratings loaned by the Royal Navy to the Canadian service. To accomplish this an establishment must be provided to afford necessary training to boys and youths, in order that they shall be proficient in their duties when placed aboard ship. Instruction will include seamanship, gunnery, signalling, wireless telegraphy, physical training, engine-room training, ordnance training and stoker's training.

The boys trained at this school will also be given courses in the usual academic subjects up to and including second year high school.

Accommodation will be provided for one hundred boys, this being the number that it is proposed to enter in the training establishment. No difficulty is anticipated in securing full number as already over four hundred applications for entry have been received.

Entry will be made between the ages of 16 and 18½ years, except stokers, who will be entered between the ages of 18 and 25 years. Those entered will be required to sign an agreement to serve continuously for seven years, provided their services are required for that time. In the case of boys under 18 years of age, such period of service shall commence as from the date upon which they attain the age of 18. The average period of shore training is nine months, although boys possessing exceptional aptitude may qualify for transfer afloat in six months.

H. M. C. DOCKYARDS, HALIFAX AND ESQUIMALT

Concurrent with the other services of the department, a complete reorganization of the technical branches of both dockyards was effected. The management of dockyard workshops has been much simplified and has been placed under the charge of an engineer manager. The reorganization has resulted in a considerable reduction of both labour and clerical personnel and has produced a more centralized and compact system of control and operation.

A number of workshops at Halifax which were established owing to extra work during the war have been closed. These are held in reserve, and are in condition to be put in full operation at short notice.

During the year, repairs and refits, as required, have been carried out at Halifax, to ships of the Canadian Naval Service, Imperial Navy and French Navy, and also to Fisheries Protection, Hydrographic Survey and other Canadian Government vessels.

Upon the return to normal conditions the department ascertained that known and anticipated requirements for ship repairs and refits would not justify the maintenance of Esquimalt dockyard in active operation. It was, therefore, decided to close the workshops and repair plant; this was done early in the year. The shops and equipment are in readiness for reopening without delay, should they be required.

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NAVAL INTELLIGENCE

The Department of Naval Service has now taken over from the Admiralty all intelligence work for the North American Continent. Intelligence work of the department has been placed under the charge of a trained Naval Intelligence officer. The results of this system have given complete satisfaction to the British Admiralty.

2. FISHERIES PROTECTION SERVICE

The Fisheries Protection Service is maintained for the purpose of protecting Canadian fisheries along the three-mile limit of the Canadian coasts and the international boundary line in the Great Lakes.

Foreign vessels are not permitted to fish within the Canadian three-mile limit or in the Canadian waters of the Great Lakes. They are, however, under the Treaty of 1818 allowed to call at Canadian ports for wood, water, shelter or repairs. The patrol of the Fisheries Protection Service is necessary to maintain observance of all Fisheries regulations by these vessels while passing through Canadian waters, as well as by vessels en route to the fishing grounds. A very close co-operation is maintained between the Fisheries officials, Customs officers and the Fisheries Protection officers, in order to ensure the strict observance of the Canadian regulations.

The mackerel fisheries along the Atlantic coast require most careful surveillance. Every spring the schools of mackerel arrive off the southwestern coast of Nova Scotia and follow the coast eastward on their way to their summer feeding grounds. United States fishing fleets follow the run of mackerel along the Nova Scotia coast and carry on their fishing operations throughout the journey. They are, however, not permitted to fish within the Canadian three-mile limit. The Fisheries Protection Service maintains a patrol which keeps close watch on the United States vessels from the time they arrive off the Canadian coasts until they return to their home ports with their catches.

In previous years our vessels interested themselves only in enforcing the regulations. During the past year, however, a new and important development of their work has been effected. In addition to their protective utility they have performed scouting operations for the purpose of locating the shoals of mackerel. The information obtained was sent by wireless to the shore and given to the Canadian fishermen. The fishermen were thus enabled to proceed immediately to the localities where the fish were and lost no time in locating them. The arrangement has proved highly satisfactory to the Canadian fishing interests, particularly as the run of fish this year did not approach the Nova Scotia coast so closely as in previous years and would, therefore, have been much more difficult to locate. It is hoped that this system may be continued and extended in the future.

On the West coast the seal patrol required closest attention. Under the terms of the Pelagic Sealing Treaty, pelagic sealing, that is seal fishing at sea, is prohibited by international arrangement. The Indians are, however, permitted to capture sufficient seals for their food supply, the seals to be killed by spearing only. Very careful patrol is necessary to ensure that the Indians do not use rifles in capturing seals. The Fisheries Protection patrol enforces, so far as possible, the regulations with reference to sealing and investigates any reported illegal seal fishing.

It also protects the Canadian salmon fisheries against foreign fishing vessels.

The West coast ships were also used, whilst on their regular patrol, for carrying supplies, etc., to the isolated Radiotelegraph Stations on the British Columbia coast.

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The following is a table of the Fisheries Protection vessels in commission during the past year:—

Name of Ship.	Captain.	Size.		Speed. Knots.	Station.	Remarks.
		Length.	Beam.			
C.G.S. <i>Arras</i>	J. E. Morris.....	130	25	10	Northumberland Strait Division.	
<i>Arleux</i>	William J. Milne..	130	25	10	Bay of Fundy.	
<i>Hochelaga</i>	Clement Barkhouse.	210	278 6	14	General East Coast Service.	
<i>Petrel</i>	G. A. Burton.....	116	22	11	Nova Scotia Coast west of Halifax.	
<i>Bécancour</i>	P. C. Robinson...	100	22	13	Lake Erie, Eastern end.	
<i>Lavaltrie</i>	H. P. Cousins.....	91	22	9½	Lake Erie, Port Stanley Division.	
<i>Laviolette</i>	E. S. Bailey.....	91	22	9½	Lake Erie, Western Division.	
<i>Armentières</i>	J. A. Baillies.....	130	25	10	General Patrol (two months).	June-October loaned Tidal Surveys; October-March laid up.
<i>Malaspina</i>	George Ford.....	160	26½	14½	West Coast Vancouver Island.	
<i>Stadacona</i>	Holmes Newcomb	196	33 6	12	General West Coast Patrol.	
<i>Thiepval</i>	H. Adlam.....	130	25	10	General West Coast Patrol.	

All the Fisheries Protection vessels during the past year were re-commissioned under the Blue Ensign. During the war these vessels were attached to the Royal Canadian Navy and had the privilege of flying the White Ensign but with their return to the Fisheries Protection Service proper, they were commissioned under the Blue Ensign.

On the East coast the *Arras*, *Arleux*, *Hochelaga* and *Petrel* were laid up in the fall, as were also the three vessels engaged on the Great Lakes.

On the West coast the *Thiepval* only was kept in commission on patrol work during the winter of 1920-21.

The department considered that in view of the necessity of economizing, the number of vessels in commission during the winter months should be reduced to the minimum for the past season. It considered that all the vessels on the East coast should be placed out of commission for the winter and that the *Thiepval* on the West coast would be sufficient to retain in commission for protective purposes.

C.G.S. Arras.—The *C.G.S. Arras* was placed in commission at Halifax on the 1st April, 1920. The vessel proceeded to Cape Sable on mackerel scouting and patrol duties. Working with *C.G.S. Hochelaga* the *Arras* met the United States mackerel seining fleet off Shelburne and continued on scouting duties along the Nova Scotian coast to the eastward, up to the 18th June, when the United States fleet left our coast. The *Arras* then proceeded to the Northumberland Strait Division and took up her station, with headquarters at Pictou. Cruising on this station was continued up to the latter part of October when the vessel returned to Halifax where she was paid off on the 31st October. During the season the vessel succeeded in refloating the schooner *Milo*, ashore near Georgetown, P.E.I., and also rendered assistance to the British steamer *Clare Hugo Steines*, ashore on Amet island shoals. The vessel reported that twelve United States mackerel seining vessels and thirty-six United States bank fishing vessels visited the Canadian coast during the season. The vessels were care-

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fully watched to ensure that no infringements of the fisheries laws were made. The vessel was in commission for seven months during the year.

C.G.S. Arleux.—The *C.G.S. Arleux* had been in commission during the previous winter on ice-breaking duties and at the commencement of the season was undergoing refits. On the 17th May the *Arleux* resumed her Fisheries Protection duties, working in conjunction with the *Arras* and *Hochelaga*. The vessel sighted the schools of mackerel off Shelburne county, kept in touch with them and sent daily reports of their movements to the coast. This work was continued up to the 21st June. The *Arleux* reports that the fishing fleets made good catches but that the fish kept a long distance off shore and that the shore fishermen were not so successful. On the 23rd June the *Arleux* took up its regular station in the Bay of Fundy and approaches. Care was taken to prevent the dynamiting of fish and also, along the shores of St. John County, careful check was kept on the drift net salmon fishermen. The vessel also located a number of illegally set lobster traps which were destroyed. Assistance was rendered in putting into effect a system of registering, numbering and painting the names on all Canadian Fishing vessels operating in the district, in order that they may be easily recognized from the United States boats. This system not only aids in the detection of United States poaching vessels but is also of great assistance in the prevention of smuggling. During the season several attempts were made to float the schooner *American Eagle*, ashore on the west side of Grand Manan. These attempts were unsuccessful and the vessel became a total loss. The *Arleux* also towed the Little Wood Island lifeboat to St. John for repairs and carried out direction finding tests with the Cranberry Point and Red Head Direction Stations. The vessel reports that sardines were plentiful in St. John and Charlotte counties, but that the prices paid were small and the demand limited. This factor, together with the high cost of material, resulted in a poor year for those employed in this line of fishing. The same difficulty was found with line fishing. The vessel was paid off at the end of November. During the year it was in commission six and a half months and steamed over 7,000 miles.

C.G.S. Hochelaga.—The *C.G.S. Hochelaga* went into commission on the 1st April, 1920. On the 15th April the vessel proceeded to Blanche, N.S., with a new lifeboat and returned the old boat to Halifax. On the 3rd May the *Hochelaga* went on patrol duty in connection with the mackerel fisheries and worked in conjunction with the other Fisheries Protection vessels until the end of May. During the season the vessel performed various patrol duties on the Nova Scotian coasts and on the Northumberland Strait patrol. Work in connection with Radiotelegraph inspection and supply was carried out during the period that this ship was on patrol duties, including stations on the St. Lawrence, Labrador and Newfoundland coasts. The vessel was paid off on the 31st October. Whilst employed on the duties assigned it during the year, a close watch was kept on fishing activities. The vessel reports that the result of the mackerel scouting patrol was highly satisfactory. The vessel was in commission seven months during the year and steamed 8,462 miles.

C.G.S. Petrel.—The *C.G.S. Petrel* was commissioned on the 1st April, 1920. Cruising was taken up on the western Nova Scotian division and the ship called at various harbours for the purpose of collecting fishing information. Assistance was also rendered the Fisheries service in carrying out lobster factory inspection. During May and up to the 24th June the vessel was engaged on mackerel scouting and patrol duties, after which she returned to Halifax and thence to her regular station. The vessel was also utilized for the delivery of confidential matter to the collector of custom at Yarmouth. A sharp lookout was also kept for reported smuggling vessels. On the 1st October the vessel was ordered to proceed to the Prince Edward Island station, where cruising was carried out up to the end of October. The vessel then returned

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to Halifax and was placed in winter quarters towards the end of November. The officers boarded many United States fishing vessels whose papers were examined. No poaching or illegal fishing was observed during the season. The vessel reports that lobsters were plentiful in some localities. The cod fisheries were generally good but prices were low; good catches of pollock were also made. The fall run on mackerel was good although the shore fishermen were not successful owing to the fact that the fish were well off shore. During the season assistance was rendered to the schooner *Ruby Pentz* and also to two disabled motor boats. The deck hands of the *Petrel* were given boat drill, signalling practice and seamanship lessons. During the year the vessel was in commission eight months and steamed 6,000 miles.

C.G.S. Becancour.—The *C.G.S. Becancour* was transferred to the Fisheries Protection Service from the Department of Marine and went into commission at Sorel, P.Q., on the 11th May, 1920. The vessel proceeded to lake Erie and took up its station at Port Dover on the 2nd June. From the time of arriving in lake Erie a constant watch was kept for illegal fishing along the international boundary line at the east end of the lake. The vessel remained in commission until the 31st December. During the season 344 nets were seized, mostly belonging to United States fishermen, who had set them north of the boundary line. The vessel was in commission seven and a half months and steamed 3,192 miles.

C.G.S. Lavaltrie.—The *C.G.S. Lavaltrie* went into commission at Sorel, P.Q., on the 11th May and accompanied the *C.G.S. Becancour* to lake Erie. The vessel patrolled the international boundary line along the central division of the lake. In October it was considered advisable to lay up the *Lavaltrie* as the amount of work left did not warrant keeping the vessel in commission. The *Lavaltrie* was accordingly paid off at the end of October. The vessel was in commission five and a half months during the year.

C.G.S. Laviolette.—The *C.G.S. Laviolette* was commissioned at Sorel on the 12th June and proceeded to lake Erie, western division, to take up her duties. The vessel remained on patrol duty until November, after which she undertook fish hatcheries work until the 8th December, when she was laid up at Amherstburg. As fisheries activities commence very early in the western end of lake Erie, it was arranged to have the *Laviolette* ready for commission by the middle of March, 1921. The vessel was in commission six months.

C.G.S. Armentieres.—The *C.G.S. Armentieres* was commissioned for general service on the west coast on the 1st April, 1920. She carried out general fisheries protection duties for a period of two months, after which she was loaned to the Tidal and Current Survey Branch. She remained in that service until October, when she was paid off. The vessel was in commission seven months during the year.

C.G.S. Malaspina.—The *C.G.S. Malaspina* was commissioned at Esquimalt, B.C., on the 1st April, 1920. The vessel was utilized during the month of April for inspection of wireless stations, transferring Radiotelegraph operators and landing Radiotelegraph stores at the various isolated stations. About the middle of May the vessel proceeded to the west coast of Vancouver island, where the sealing patrol operations were undertaken. The vessel continued on these duties throughout the summer and autumn, when she returned to Esquimalt and was paid off. During the winter necessary repairs and refits were carried out, in preparation for recommissioning on the 1st April 1921. During the year the vessel was in commission eight months.

C.G.S. Stadacona.—The *C.G.S. Stadacona* went into commission at Esquimalt, B.C., on the 1st April, 1920. The vessel was employed in connection with the training of Naval Cadets until the end of May, after which she carried out general patrol duties

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until the end of October, when she was laid up. The vessel was in commission for a period of seven months during the year.

C.G.S. Thiepral.—The C.G.S. *Thiepral* was commissioned on the 1st April, 1921, and proceeded on Fisheries Protection duties along the west coast of Vancouver Island. The vessel returned to Esquimalt at the end of April and was placed under the direction of the Chief Inspector of Fisheries for British Columbia on the 18th May, and carried out various duties under his direction until September. From September until March 21, this vessel carried out all Fisheries Protection duties on the West coast, the others having been paid off for the winter months. The vessel was in commission practically the whole year except for short periods when she was in dockyard hands making good minor defects.

3. SURVEY OF TIDES AND CURRENTS

The work of this survey has been carried on successfully and with considerable extension, during the fiscal year. Further investigations of the currents in the passes of British Columbia have been made, both on the main ocean routes of steamers and in passes used by the lumber industry. A series of new tidal stations were established during the season in Eastern Canada; and an investigation of the currents in St. John harbour was made in co-operation with the Public Works Department. The six principal stations in Eastern Canada have been maintained, as well as the six stations on the Pacific coast; although on that coast the winter has been exceptionally stormy, and some damage resulted to the tidal stations, which was temporarily repaired at the time. It is from these twelve tidal stations that tidal information is obtained as a basis for the calculation of tide tables for future years. A branch of the work, which is of much importance, is the improvement in methods of calculation, and in the data by which the turn of the current can be computed. Much has been done during the year in revising and improving the data for these purposes.

OBSERVATIONS AND METHODS OF CALCULATION

In conducting this survey, the problems of most immediate importance to navigation at the outset, were specially with regard to the time of the tide and its relation to the movements of the current. It is now becoming possible, however, to give more attention to questions regarding the rise and the range of the tide, with a view to their systematic reduction and classification. These questions are coming under the notice of international conferences; and it is important to devise some system of classification for the rise of the tide and its variations, which will accord in general with methods which can be adopted for other countries also, so that the data may be published everywhere on a uniform system.

In dealing with time values, the main problem was to find a standard port with which the differences of time for secondary harbours were reasonably constant. This has been accomplished by dividing the whole extent of our coast into regions with a suitable standard port for reference in each of them. In doing so, the endeavour was made to reduce the number of these standard ports to the fewest possible. In the case of some important harbours, it has not been possible to obtain constant time-differences with any of the principal tidal stations; and it has been necessary to calculate special tables for these. This is done for Pictou in Northumberland strait, Yarmouth, N.S., and Portage island at the entrance to Miramichi bay. For this last, the time of high water and low water are calculated separately from two independent ports of reference, by means of variable differences. During the year the data for those calculations have been thoroughly revised, and their basis extended by the reduction of further observations.

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The method of dealing with slack water at the turn of the tidal streams is similar. Special tables are calculated for the Traverse on the lower St. Lawrence, and for five passes in British Columbia. These five may be considered as standard passes to which a number of others can be referred by differences of time. In this way, the time at which the current turns can be found in six other passes and narrows in southern British Columbia, and eight in the northern waters.

The principal revision of calculation values for these passes was as follows:—

First Narrows.—From farther observations obtained since the dredging to enlarge the channel-way, was completed. A comparison of the earlier and later years has enabled a slight change in time to be allowed, which has resulted from the dredging. This will make the slack water tables quite accurate under the new conditions.

Seymour Narrows.—The observations obtained during a complete year, as referred to in last year's report, have afforded a basis for the revision of the values for the calculation of slack water in this important pass. The method of computation and the variations allowed for, are of a highly technical character; but the revision has shown that no appreciable change in the values would occur if further observations were incorporated as a basis for them. The method of calculation is thus as accurate as it can be made; which is a satisfactory result to arrive at, in the case of so important a pass, especially when eight other passes are referred to it by differences of time.

Active Pass.—An improvement was obtained here also, from further observations, by making allowance more accurately for the diurnal inequality in the differences of time in relation to the large tides and half tides. This is an improvement in method, although the values themselves are only altered by one minute in the revision made, which shows as before how closely correct the calculation values now are as working averages.

Nelson.—The values by which the time of low water at Nelson are computed, were also revised during the year, by incorporating further observations in the series on which they are based. The improvement resulting from all the revisions here referred to, will add to the accuracy of the tide tables for 1922, which were calculated during the past winter.

TIDAL AND CURRENT OBSERVATIONS DURING THE SEASON OF 1920

The region under investigation last season was the Atlantic coast of Nova Scotia. The principal tidal station recently established at Halifax enabled a series of localities along that coast to be investigated simultaneously with it. This work was under the supervision of Mr. H. W. Jones. The tidal stations established were at Guysboro, Sonora at the mouth of St. Mary's river, Sheet Harbour, Lunenburg, Liverpool and Shelburne; a series of six stations at which tidal record was obtained simultaneously with Halifax. The time of the tide at these localities could thus be determined relatively to Halifax; and care was also taken in reducing the observations to arrive at concordant low-water datums at all these localities, which would agree with the datum already established at Halifax.

At Moncton on the Petitcodiac river, a pressure gauge was installed with two objects in view; to test the working of such a gauge, and also to determine the time of arrival of the Bore. The gauge worked by air pressure; and it was already evident from trials in previous seasons, that in the extremely muddy waters of the Bay of Fundy it is necessary to make the whole air system both air-tight and water-tight, to prevent chokage by mud. The pressure of the water was taken by an inflated rubber cushion connected by fine tubing to a registering pressure gauge. This apparatus

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answered admirably in recording the time of arrival of the Bore; as within a few seconds of the passage of the breaking wave at the head of the Bore, the indicator would rise on the gauge. The time was thus indicated accurately within a small fraction of a minute, which was more closely than it could be read on the graduated paper. On the other hand, it was found impracticable to obtain the height of the tide with reference to any fixed zero line. Every day the curve representing the tide would be in a different position on the diagram according to the amount of the initial air pressure, to which the pressure of the water was added. It might be possible by means of careful comparisons with a fixed scale, to determine a datum day by day; but even with these comparisons the reduction for height proved to be complex and at times uncertain. This gauge was erected under the supervision of Mr. R. B. Lee, and the superintendent gave personal attention to the matter with a view to securing the best results, as it has long been felt that a pressure gauge would be very convenient at localities where no wharves exist; as well as in the Bay of Fundy, from the wharves which end at half tide, cut to the low water mark. The result of these observations enabled better values to be arrived at for the calculation of the time of the Bore, which is published in one of our pocket editions.

During the season several of the principal tidal stations were inspected, including St. Paul Island which has now become difficult of access on account of the irregular sailings of the steamer calling there. It is important to keep this station in thorough repair and its instruments in adjustment as it commands so large an extent in the gulf of St. Lawrence.

A special investigation of the currents at the mouth of St. John harbour was undertaken to assist the Public Works Department in deciding on questions relative to the extension of breakwaters there. The points of chief importance were to determine the volume of flow at various stages of the tide in the vicinity of the main channelway inside of Partridge island, in order to estimate the probable effect upon the current of the extension of either of the breakwaters. It was soon found that surface appearances were quite misleading for on the surface the current is almost always outwards, whereas underneath a reversed current inwards may occupy a large part of the area of the channelway towards the bottom. This occurs generally during the rise of the tide. The investigation of the conditions was carried out from scows anchored in suitable positions, by means of current meters which could be lowered to any depth and which registered electrically without being disturbed. The strength of the current and its direction, whether inwards or outwards, can thus be ascertained at any depth and at any stage of the tide. This work was carried out under the supervision of Mr. H. W. Jones, during some weeks in the middle part of the season and the details were communicated to the harbour engineer in the Public Works Department at St. John.

Observations of slack water at Reversible falls, above the St. John harbour, were also obtained throughout the season. It happened that a resident engineer of the Canadian Pacific Railway, Mr. C. F. Draper, was at this spot in charge of the erection of the new bridge, and he kindly undertook to supervise the observations. The time at which slack water occurs was determined with reference to high and low water at St. John, as published in the tide tables, and this result will be very serviceable to navigation from the harbour into the river above. The amount of traffic here is very considerable and it is, of course, only possible at slack water. This information will therefore be quite an advantage to the river traffic.

On the Pacific coast the observations in Seymour narrows were continued throughout the winter and up to the end of June. In this way a complete year of observation was obtained for the first time, which is of special importance in this case because the particular tides which are missed in the summer are obtained in the day time in the winter. The reduction of these observations has therefore afforded

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a more balanced series as a basis for the values which are used to calculate slack water in advance. The improvement in the calculation values already noted was thus obtained. Observations of the turn of the current at Dent islands, four miles above the Yuculta proper, were begun in the early summer. This is a matter of importance for the lumber industry, which takes this route more than any other. In towing booms of logs, if they can depend upon the time of slack water at Dent islands, they are able to make both the rapids there and in the main Yuculta below during one slack water period, which saves the trouble of tying up and waiting for the following low-water slack. These observations have been continued during last winter to obtain a good series. The result will be reduced to a difference of time with slack water in the main Yuculta passage, for which tables are published. In Boundary pass, on the main line of ocean traffic from Vancouver to the Pacific, an examination of the currents was made with the Government steamer *Armentieres*. It was anchored at carefully selected points in Boundary pass and Haro strait, with a view to obtaining the flood and ebb direction and the velocity of the current with current meters. Valuable information was thus obtained which has been desired by the steamship lines and pilots for some years. On the whole, the ebb was found to be strong and definite, but the flood stream was more uncertain and variable in character. To obtain complete data it will, therefore, be necessary to take further observations of the time of slack water when the current turns at the points which have been selected. Unfortunately the steamer is not available for this purpose during the coming season but it will be carried out as well as possible by the use of motor-boats from camps on shore. As it could not be ascertained in advance whether the currents in these straits would best accord in their behaviour with the time of the tide, or with slack water in another of the passes, simultaneous observations were taken in Active pass. These observations serve a double purpose, both for comparison with Boundary pass and to secure a check on the calculations of slack water as now carried out for Active pass itself. The work in these various passes on the Pacific coast, as well as the observations on the steamer, was carried on personally by Mr. S. C. Haydon or under his supervision. Tidal observations at Bedwell harbour, which opens on Boundary pass, were also continued throughout the season to obtain tidal data for comparison with the current.

An endeavour has been made in the seasons of 1919 and 1920 to obtain data for slack water on the Fraser river, at its mouth in the vicinity of Steveston, and further up at New Westminster. It has proved difficult, however, to obtain satisfactory results as observations cannot be taken with advantage during the winter rains and in summer the freshet in the river continues during the best months for good weather. During the freshet period the current continues in one direction without turning, and in the season of 1920 the level of the river remained high almost until autumn. It is proposed, therefore, to continue this endeavour until more consistent and satisfactory results can be obtained. This would be a distinct advantage to transportation, carried on by towing on the Fraser river.

HEIGHT OF THE TIDE AND TIDE LEVELS

It is becoming increasingly necessary to obtain correct data regarding the rise of the tide and its variations during the course of the month, in accordance with the position of the sun and moon. This question is occupying the attention of international conferences with a view to obtaining a uniform system for these data in the world generally. In the early days of this Survey, it was found that the rise of the tide had been determined at so many localities around our coasts during the surveys of the British Admiralty, that our new work was brought into relation with these, on the assumption that during these original chart surveys the rise of the tide had

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been determined in accordance with a uniform system. We have now tidal record at so many localities, however, obtained day and night with registering instruments which give all the variations and inequalities, that it has become possible to revise the rise of the tide throughout extended regions, and to give values which are truly consistent and comparative. The first step in arriving at this result is to establish a low-water datum for each locality which has a consistent relation to the level of average low water throughout the region. In this work the old Admiralty determinations can still be utilized for comparative purposes at intermediate localities, at which later observations have not yet been obtained.

In the season of 1919, a series of tidal stations were established in the upper part of the Bay of Fundy, and at specially selected localities low water was obtained directly by instrumental levelling. From this information it was possible to revise the rise of the tide throughout the whole of the upper part of the Bay of Fundy above St. John. A low-water datum was established at this series of localities in correspondence with the datum at St. John, relatively to low water. The rise of the tide is thus made truly comparative everywhere. The leading variations throughout the course of the month are now determined and also the true ratio of the range with the principal tidal station at St. John, and are published in the Tide Tables.

The observations of last season along the Atlantic coast of Nova Scotia have been dealt with in a similar way. A uniform series of low-water datums has been determined for the various localities, consistent with the low-water datum at Halifax. The rise of the tide from Louisburg to Cape Sable has been revised to obtain its true relative amount at both springs and neaps. This will bring the whole coast-line to a consistent basis, and at all the localities where observations have been obtained, permanent bench-marks have been established for reference, from which the datum and other tide levels can always be obtained correctly by instrumental levelling if required for construction purposes or for reference in dredging.

For the St. Lawrence estuary below Quebec to Anticosti, an extent of 400 miles, a large amount of information has now been obtained at a number of localities, partly through co-operation with other surveys. During last winter, the whole of this information was collated to bring all the low-water datums into harmony and to determine the rise of the tide correctly at springs and neaps, as well as its other variations during the course of the month. In this estuary the semi-monthly variation with the distance of the moon is relatively large, and the diurnal inequality between the two tides of the day is more pronounced at high water than at low water. All these variations are correctly shown in the primary tide tables published for Father Point, which is situated in the middle of the length of the estuary; but it is not easy to see how these variations in the height of the tide at other localities can readily be deduced from these tables. Meanwhile, the rise of the tide at springs and neaps has been carefully determined as an average value in each case. This will give in the tide tables for next year a consistent series of values for the St. Lawrence estuary, to indicate the amount of rise at successive localities and its increases with the progress of the tide.

It is hoped as time goes on to carry out a similar revision for other regions where this has not been done. The corresponding levels of the low-water datum which will result, will be of much value for purposes of construction and of dredging, as well as for surveys of harbours in these regions.

HUDSON BAY AND STRAIT

The only further observations that were obtained in this region were at Nelson, where a tide gauge was kept in operation throughout the season, through co-operation with the officials of the Railways and Canals Department, who reside there. From

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these a revision was made of the calculation values for the time of low water at Nelson, which will improve the tide tables there for next year. During the year a tabulation and reduction was made from the observations already obtained at Churchill and results have been arrived at which will enable approximate tide tables to be calculated for that harbour if this should come to be required. Arrangements have also been completed with the Hudson's Bay Company, which has kindly offered to co-operate in obtaining tidal information at some of its posts. The most important of these is Amadjuak in Hudson strait, where it is proposed to establish a new centre for the development of Baffins land. Three recording tide gauges with complete outfit and instructions for erecting and operating them have been supplied to the Hudson's Bay Company for this locality and two others on the eastern shore of Hudson bay, where no tidal information is yet available. Captain G. E. Mack, Superintendent of Bay Transport, has kindly undertaken to see to the erection of these gauges during the coming season. This will be a valuable step towards completing the tidal information around this large water area and throughout James bay, in case of any future development in those regions, for which tidal information would be of service as one of the first requirements.

CO-OPERATION AND PUBLICATION

During the season two tide gauges were placed in the entrance to the St. Lawrence in co-operation with the Hydrographic Survey. They were at Mont Louis on the Gaspé coast, and Caribou islets on the opposite shore. In the tide tables previously there was a considerable gap between cape Chat and the extremity of the Gaspé peninsula. The points on that coast are difficult to reach over land and there is thus considerable advantage in obtaining tidal information while the hydrographic surveys are in progress. A reliable datum for the chart work is also obtained in this way from registering instruments. On the Pacific coast a tidal gauge was installed by the Hydrographic Survey at Quatsino near the northwestern end of Vancouver island. The difference of time is not great all along the outer coast of that island and the observations at Quatsino will afford a check upon the time of the tide at the extreme end of Vancouver island. It is proposed to carry on similar co-operation with the Hydrographic Survey during the coming season, which will result in maintaining the low-water datum on a consistent basis throughout each region.

Any new information obtained has been communicated to the British Hydrographic office for publication in their general tide tables. The most important items this year have been the new data for the rise of the tide along the coast of Nova Scotia, and the revision of the spring and neap rise throughout the St. Lawrence estuary as far as Anticosti. This will improve the data for these sections of our Canadian coast in the general tide tables, which are so much used by mariners.

During the year there have been, as usual, a large number of requests for information of very varied character. In some cases the information asked could be supplied by publications already available, but in many instances special calculations or reductions were required to arrive at the data desired. The results have been utilized for industrial development as well as for construction purposes.

The most important of the publications issued by this Survey are, no doubt, the tide tables which are calculated and published annually. In the tide tables for the coming year very substantial improvement has been made in the data themselves, as well as in the basis for the calculation of several of the tables, in the directions already indicated. A further extension of the information is the publication of the height of the tide at Prince Rupert, as well as the time. It was thought well to give this in full as the variation in the rise of the tide is not quite the same as at Port Simpson, to which it was formerly referred. In Miramichi bay the higher of the two

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high waters in the day will be distinguished by a difference of type in the printed figures. This is a matter of importance there as the variation is much greater in high water than in low water, and consequently the available draught for vessels crossing the bar at the mouth of Miramichi bay will be more definitely known, so that vessels leaving Chatham can make choice between the day or the night tide, whichever is most advantageous.

The two main editions of the tide tables and the three abridged editions, as well as the tide tables for Hudson bay, have maintained their circulation as reported for last year, with some increase in the eastern editions. The result of the tidal observations obtained during the "Canadian Arctic Expedition" have appeared during the year in a bulletin of the expedition, with this title. There was considerable delay in its issue because of the difficulty in obtaining complete data until all the parties had returned. The issue of this publication will form a considerable contribution to the scanty information previously available in these regions.

Another publication prepared by the superintendent, although of a technical character, is of value from a practical standpoint. It is entitled, "The Interpolation of Breaks in Tide Curves from Recording Instruments." It explains a method by which breaks in the continuous record of the tide may be filled in and although the process is intricate, it is of much consequence in making available the results of tidal observations. For the main purpose in view it is essential to have a complete year at a time for analysis and if any break or interruption occurs a large part of a year may thus be lost. It is therefore evident that the method described in this publication, which makes it possible to fill in a break of a week or more, may obviate the loss of much valuable tidal record for analysis, although the record may still serve for other purposes, such as comparisons with secondary stations.

The local tide tables required by other departments were again calculated and supplied to them. A table giving the height of the tide at low water at Port Borden throughout the year, for the benefit of the train ferry service to Prince Edward island, was supplied to the Railways and Canals Department. The tide tables required for a special publication for the St. Lawrence pilots, were also prepared and supplied to the Marine Department. Advance information regarding slack water at Dent islands, in the Yuculta, B.C., was sent to the leading companies interested in water transportation by towing, on the Pacific coast.

4. THE LIFE-SAVING SERVICE

The Life-Saving Service was taken over by the Department of the Naval Service on May 1, 1914. The service at the time of transfer was composed of forty-two life-saving stations, twenty-seven of which were situated on the Atlantic coast, eleven on the Great Lakes and four on the Pacific coast. In addition to the operation of life-saving stations, the department has undertaken, during the period of its jurisdiction over life-saving operations, to reward bravery for life-saving at sea. From 1914 to 1918, careful observation was made to determine what useful service each life-saving station was rendering. In this connection it should be noted that many life-saving stations, which were established in the days of sail-driven and oar-propelled fishing vessels, were not called upon to render assistance where the sailing craft and row-boats had been replaced by motor-driven craft. In the years 1918 and 1919 the following stations were closed down: Richibucto, N.B.; Pictou Island, N.S.; Port Mouton, N.S.; Whitehead, N.S.; Ucluelet, B.C.; Collingwood, Ont.; Port Hope, Ont.; Consecon, Ont., and Cheticamp, N.S. In 1919 Toronto Life-Saving Station was burned down and in place of rebuilding it an arrangement was made with the Toronto Harbour Commission whereby they would take over the operation of the station. It was agreed upon that a certain sum would be paid to the Toronto

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Harbour Commission each year to cover any expenses which they might incur in protecting general navigation on lake Ontario, in which phase of operations the department was solely interested.

The abolition of these stations left, in 1920, twenty-seven life-saving stations still in operation. In the interests of economy the system of life-saving inspection was altered by the department while that service was under its administration. The inspector of life-saving stations, whose duty it had been to carry out inspection work in the life-saving service, was discharged and the inspection work was performed by the various officers of the Fisheries Protection Service patrolling in the vicinity of the life-saving stations. The Fisheries Protection officers performed the inspection duties without additional remuneration and in the ordinary course of their patrol work, so that a considerable saving was effected and the system of inspection was greatly improved. Consequent upon the reorganization of the Naval Department it was decided to allow the Life-Saving Service to revert to the Department of Marine and Fisheries. Under authority of Order in Council 1316 of June 12, 1920, the service was accordingly transferred to the Department of Marine and Fisheries to date from July 1, 1920, and all unexpended balances of parliamentary appropriation for rewards for life-saving, including life-saving stations, were transferred to the Department of Marine and Fisheries.

5. HYDROGRAPHIC SURVEY

Five parties belonging to the Hydrographic Survey were in commission during the past year, as follows:—

Atlantic coast party, under Captain F. Anderson.

Lower St. Lawrence party, under Mr. C. Savary.

Great Lakes party, under Mr. R. J. Fraser.

Pacific coast party, under Mr. H. D. Parizeau, in Hecate strait, and a detached party under Commander J. H. Knight, in Quatsino sound.

ATLANTIC COAST SURVEY

Captain F. Anderson and his assistants left Ottawa to join C.G.S. *Acadia* at Halifax on June 22, 1920. Between that date and the beginning of September the party carried out offshore soundings between Liscombe harbour and cape Canso. The object of this survey is to more accurately define the banks fronting that part of the Nova Scotia coast. This work continued throughout the clear weather as the banks are a long distance from shore but during periods when the weather was not clear and objects could not be distinguished for any great distance the party checked up and fixed the position of many of the shoals marked on the present Admiralty charts. In September the party proceeded to Magdalen islands where various reported and uncharted shoals were investigated. They were successful in finding quite a number of shoals not shown on the charts at present in use. In view of the inaccuracy of the old charts it has been decided that a detailed survey be made of the Magdalen islands and the waters surrounding them. About the middle of September work was undertaken on harbour surveys at cape Tormentine and Port Borden, as well as that portion of Northumberland strait lying between these ports. This survey was completed toward the end of October. Large scale plans of the two terminals and the strait have been prepared for the engraver and photolithograph copies will be issued shortly. During the season advantage was taken of the visit to Magdalen islands and Northumberland strait to obtain new values for the declination in those localities. A table giving the declination observed by this survey in the last few years is given at page 24. Experiments were again made with the Radio-telegraph Direction Finding Stations with the object of improving the method for

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fixing the positions of ships offshore. It is hoped to use these stations for examining the banks farther off the Nova Scotia coast than land survey stations will allow. The party returned to Halifax on November 10 where the *Acadia* was laid up, the staff returning to Ottawa to work up their season's notes.

LOWER ST. LAWRENCE SURVEY

The Lower St. Lawrence party was in charge of Mr. Charles Savary and used the C.G.S. *Cartier*. The party left Quebec on May 6 and commenced work in the vicinity of Martin river with Ste. Anne des Monts as a base. A part of this survey worked from shore. A very successful season's work was carried out up to November 1 when the party returned to Quebec. The vessel was laid up for the winter there and the survey staff returned to Ottawa. During the season the shore line between Martin and Magdalen rivers was completed, using the water triangulation to fix the various points. Boat sounding and ship sounding over this part of the coast was completed to determine the 100-fathom line. On the north shore water triangulation was used to connect Pte. des Monts to Seven islands and the coast line between Pte. des Monts and Pentecote river with its offshore soundings was completed. Large scale plans have been made of mont Louis on the south shore and Shelter bay on the north shore. About 70 miles of traversing was completed during the year and 1,400 lineal miles of boat sounding, and over 1,000 miles of sounding from the ship's deck was carried out.

GREAT LAKES SURVEY

The Great Lakes Survey party under R. J. Fraser joined the C.G.S. *Bayfield* at Owen Sound on the 12th May, 1920, and proceeded to Michipicoten harbour, where they arrived on the 15th May. During the season the area between Gargantua harbour and point Isacor was charted and in addition large scale plans of Michipicoten and Gargantua harbours were made. Considerable sounding in deep water was also completed to the northeastward of Caribou island. Owing to boiler trouble it was decided to install the new boiler for the *Bayfield* at Port Arthur, and on the 23rd September *Bayfield* proceeded to that port and was laid up at Port Arthur for that purpose. During the season the weather was good for surveying operations, but owing to labour difficulties full advantage could not be taken of the opportunities afforded. The working season amounted to 18½ weeks and in that time 90 miles of traversing was completed in addition to 240 miles in shallow water and confined waters and 920 miles in deep water. On the 7th November a report was received of an obstruction in lake St. Louis. Mr. Fraser and an assistant were sent to investigate. The obstruction was located near the Melocheville range and it will be marked on the charts.

PACIFIC COAST SURVEY

Owing to the death of Lt. Commander P. C. Musgrave, R.N., on the 17th February, 1920, Mr. H. D. Parizeau, who had been in charge of the Great Lakes Division, was appointed as officer in charge of the Pacific Coast Survey and assumed his duties on the 11th March, 1920. Owing to labour difficulties the *Lillooet* was not placed in commission until the 5th June. The Pacific Coast party did not, however, wait for the commissioning of the ship but began work from boats between Race rocks and Seabird Point light on the 20th April and continued up to the 1st June, thus making a beginning on the work of charting the approach to Victoria harbour. The weather for this work was not favourable, high winds having been encountered. On the 6th June the party left Vancouver in the *Lillooet* to carry out a resurvey of First narrows, Vancouver harbour. As considerable dredging had been done in these narrows and as there was still some doubt of how well it was

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cleared up, sweeping operations were undertaken with a wire drag and several lumps were located. They have since been dredged out and the channel north of Parthia shoal now seems fit for use by deep draft vessels. Work at Vancouver was completed on the 7th July and the party proceeded to Ocean Falls where some changes in the topography of the harbour were surveyed and a new shoal and beacons located. Queen Charlotte city was reached on the 16th July and work in Hecate strait taken up. A series of large buoys were moored as far offshore as circumstances would permit of their being fixed. This method of carrying the sounds across Hecate strait has proved highly satisfactory. Unfortunately, for the success of the party, the crew went on strike and almost all of them left off work on the 16th August. A new crew could not be obtained prior to the middle of September and the ship was obliged to lie idle during the whole of that time. When work was resumed it was found that all of the buoys that had been placed in Hecate strait were missing. Owing to the loss of the buoys a change of base had to be taken up and the sounding of the strait abandoned for another season. The party returned to Victoria on the 12th October and the ship was laid up. During the season the party completed 7 miles of traversing, 100 miles of sounding in shallow and confined waters, and 350 miles sounding from the deck of the ship. The weather during the season was specially good.

In addition to having the steamer *Lillooet* for work in British Columbia the Hydrographic Survey also borrowed C.G.S. *Restless*. Although small this vessel proved very useful in confined waters but is unable to undertake work on the outward coast. Whilst in commission with the Hydrographic Survey the *Restless* was in charge of Commander J. H. Knight. The *Restless* went into commission on the 1st May and reached Quatsino Sound on the 9th May. A resurvey of that important inlet where large pulp and paper mills are established at Port Alice was undertaken. The earlier and quieter part of the season was used for surveying the outer portion of the sound in the vicinity of Hecate cove, Bergh cove, Quiet cove and Koprino harbour. After the 20th August work was transferred to the south arm in which is situated Port Alice and the survey was completed on the 1st October. Tidal observations were taken northeast of Limestone island and some triangulation was taken outward beyond the summer's work in preparation for the future. The vessel returned to Esquimalt on the 15th October where she was laid up. In addition to the ordinary surveying work and the preparation of a chart two uncharted dangerous rocks were found in Quatsino sound and Notices to Mariners prepared. Labour difficulties and bad weather interfered seriously with the operation of the *Restless* party. Of the 135 working days, it was impossible to work on 22 of them and on many other days operations could only be carried on for short periods. The party traversed 81 miles of shore line and carried out 210 miles of boat sounding during the season.

AUTOMATIC GAUGES

The work of automatic gauges is under the charge of Mr. Charles A. Price. During the season there were 33 automatic gauges in operation, 22 of which were in commission during the whole year, the remainder having been operated during the summer season only. Five new gauges were installed in the St. Lawrence river for seasonal operations and the gauge at Pte. Platon was discontinued. Demands for information obtained from the operation of automatic gauges is increasing from year to year, particularly as the record of these gauges extends over a number of years and comparisons from year to year can readily be made. A table of monthly mean water surface elevations obtained from the gauges operated during 1920 is given at page 25. The daily mean records have been carefully tabulated and are compiled in such form that photostat copies can be made at short notice for persons requiring information on water levels. At the upper entrance of Lake Superior, a remarkable

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seiche was recorded during the past year. Mr. Charles Price, Officer in Charge of Automatic Gauges, has prepared a comprehensive report on seiches which it is considered advisable to publish. The report is appended at page 36.

ISSUE OF CHARTS

During the past year the following new engraved charts were issued:—

- No. 51—Lake St. Francis.
- No. 59—Kingston Harbour.
- No. 64—Kingston to False Ducks.
- No. 65—Toronto Harbour
- No. 110—Caribou Island to Michipicoten Island.
- No. 113—Black Bay.
- No. 114—Port Arthur and Fort William.
- No. 142—Lake of the Woods.
- No. 211—Father Point to Pte. aux Orignaux.
- No. 415—Sydney Harbour.

The following new photolithographed charts were issued:—

- No. 216—Halifax Harbour.

The following reprints of former issues have been published:—

- No. 2—St. Lawrence river, Longue Pointe to Varennes.
- No. 4—St. Lawrence river, Ile Marie to foot of Ile Bouchard.
- No. 11—St. Lawrence river, Three Rivers to Becancour.
- No. 20—St. Lawrence river, St. Nicholas to Quebec Bridge.
- No. 21—St. Lawrence river, Quebec Harbour.
- No. 22—St. Lawrence river, between Montreal and Sorel.
- No. 23—St. Lawrence river, between Sorel and Batiscan.
- No. 24—St. Lawrence river, between Batiscan and Quebec.
- No. 54—Lake of Two Mountains, eastern portion.
- No. 55—Lake of Two Mountains, western portion.
- No. 92—Chantry Island to Cove Island.
- No. 93—Byng Inlet and approaches.
- No. 94—Little Current.
- No. 96—Cape Hurd to Gull Island.
- No. 103—Copper Island to Lamb Island.
- No. 105—Jackfish Bay.
- No. 112—Nipigon Bay.
- No. 142—Lake of the Woods, two editions.
- No. 201—White Island to Pointe aux Orignaux.
- No. 209—Saguenay river, St. Fulgence to Shipshaw.
- No. 303—Tree Bluff to Kinahan Island.
- No. 405—Hudson Bay, general chart.

ATLANTIC COAST MAGNETIC DECLINATION, 1916-1920.

Station.	Locality	Latitude	Longitude	Date.	Declination.	Secular Change	Observer.
Tormentine	Cape Tormentine	N. 46 08'	W. 63 47'	1920 71	25 15 4 W.'		R. W. Bent.
Cap Meale.	Magdalen I. . . .	N. 47 25'	W. 61 51'	1920 69	26 28 3 W.'		R. W. B.
Point Edward.	Sydney Harbour	N. 46 11'	W. 60 14'	1918 60	25 49 9 W.'		Capt. F. Ander- son.
Mines Point	Sydney Harbour	N. 46 14'	W. 60 13'	1918 62	25 51 0 W.'		Capt. F. Ander- son.
Durell I	Canso Harbour. . . .	N. 45 21'	W. 61 00'	1919 89	25 56 3 W.'		R. W. B.
Pisentiqai I	Canso Harbour.	N. 45 21'	W. 60 50'	1920 81	25 57 6 W.'		R. W. B.
Pilot Point.	Whitehaven Harbour	N. 45 14'	W. 61 10'	1919 87	24 20 0 W.'		R. W. B.
Brick Point	Country Harbour.	N. 45 10'	W. 61 42'	1919 84	23 56 5 W.'		R. W. B.
Pye Point	Liscomb Harbour	N. 45 00'	W. 62 01'	1916 85	23 29 9 W.'		J. L. Foreman.
Pye Point	Liscomb Harbour	N. 45 00'	W. 62 01'	1919 80	23 39 9 W.'	3 38	R. W. B.
Monahan I	Sheet Harbour	N. 44 51'	W. 62 32'	1916 84	23 05 0 W.'		J. L. F.
Monahan I.	Sheet Harbour	N. 44 51'	W. 62 32'	1919 78	23 15 4 W.'	3 53	R. W. B.
Day Cove	Ship Harbour	N. 44 45'	W. 62 49'	1916 75	22 38 2 W.'		J. L. F.
Jeddore Harb.	West Entrance	N. 44 43'	W. 63 01'	1916 72	22 37 9 W.'		J. L. F.
MacNab I	Halifax Harbour	N. 44 37'	W. 63 32'	1916 66	22 10 6 W.'		J. L. F.
MacNab I	Halifax Harbour	N. 44 37'	W. 63 32'	1919 84	22 18 8 W.'	2 56	R. W. B.
Sambro.	Sambro Harbour	N. 44 28'	W. 63 36'	1916 63	21 53 4 W.'		J. L. F.
Sambro	Sambro Harbour	N. 44 28'	W. 63 36'	1920 46	22 09 7 W.'	4 26	R. W. B.
Hubbards Cove	St. Margarets Bay	N. 44 38'	W. 64 03'	1916 67	21 52 8 W.'		J. L. F.
Krout Point	La Havre River.	N. 44 17'	W. 64 20'	1916 78	20 58 8 W.'		J. L. F.
Sand Point	Shelburne Harbour	N. 43 42'	W. 65 19'	1916 80	19 41 4 W.'		J. L. F.
Swim Point	Clarke Harbour	N. 43 26'	W. 65 38'	1920 85	20 25 0 W.'		R. W. B.

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MONTHLY Mean Water Surface Elevations of the "Great Lakes" and "St. Lawrence River," by Automatic Water Gauges in 1920.

Gauge Location.	Jan.	Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Lake Superior.....	601.91	601.82	601.88	602.12	602.42	602.66	602.88	602.92	602.75	602.60	602.29	602.10	602.36
St. Mary's River...	601.88	601.87	601.96	602.31	602.39	602.68	602.94	602.99	602.81	602.83	602.52	602.27	602.45
Georgian Bay.....	601.56	601.30	601.24	601.75	601.78	602.04	602.30	602.17	602.13	602.15	602.01	601.73	601.85
Lake Huron.....	581.56	581.64	581.80	581.34	581.98	582.24	582.52	583.06	582.44	581.59	581.15	581.00	581.86
	580.08	579.92	579.95	580.49	580.65	580.74	581.00	580.86	580.79	580.53	580.21	580.00	580.44
	580.17	579.97	580.02	580.52	580.67	580.82	581.01	580.95	580.82	580.59	580.29	580.11	580.49
Detroit River.....	572.64	572.80	573.44	574.35	574.83	575.04	575.24	575.27	575.00	574.74	574.46	574.36	574.35
Lake Erie.....	572.36	572.48	572.92	573.65	574.16	574.36	574.55	574.60	574.37	574.05	573.78	573.72	573.75
Lake Ontario.....	571.15	570.51	570.60	571.47	572.07	572.28	572.53	572.37	572.22	572.06	571.89	572.14	571.77
			From 1922nd		245.70	245.70	245.79	245.77	245.53	245.33	245.23	245.45	Till 18
	245.43	245.09	245.18	245.57	245.78	245.76	245.84	245.81	245.60	245.41	245.33	245.60	245.54
	245.25	244.95	245.00	245.50	245.59	245.54	245.66	245.59	245.40	245.22	244.97	245.34	245.33
St. Lawrence River..	244.33	243.99	244.09	244.62	244.69	244.65	244.82	244.65	244.51	244.39	244.18	244.51	244.45
	226.58	225.96	226.27	227.74	227.75	227.71	227.91	227.74	227.51	227.30	227.01	227.51	227.25
	223.56	222.95	223.19	224.39	224.45	224.44	224.70	224.59	224.37	224.15	223.82	224.21	224.07
			From 11th		152.82	152.74	152.90	152.82	152.72	152.60	152.53	153.07	
Lake St. Francis...			From 10th		151.80	151.71	151.85	151.79	151.70	151.57	151.58	152.04	
St. Lawrence River..	151.47	151.08	151.35	151.65	151.42	151.23	151.36	151.22	151.13	151.06	150.99	151.49	151.29
			From 8th		133.92	133.76	133.93	133.78	133.66	133.60	133.51	134.11	
					From 24th		95.73	95.67	95.54	95.37	95.26	95.62	
Lake St. Louis.....	71.03	72.90	74.49	70.88	69.82	68.72	68.57	68.26	67.98	67.72	67.78	68.75	69.74
Lake of Two Mountains	71.65	71.57	72.72	73.71	73.82	71.98	71.39	70.72	70.18	69.80	70.35	70.68	71.55
Lake St. Louis.....	69.35	68.12	68.52	69.88	69.55	68.43	68.25	67.90	67.66	67.48	67.52	68.36	68.42
St. Lawrence River..	68.00	66.55	66.91	68.86	68.50	67.32	67.14	66.75	66.44	66.22	66.32	67.19	67.18
					23.21	20.89	20.41	19.74	19.37	19.10	19.32	Till	24th
					21.99	19.58	19.06	18.41	18.03	17.76	17.91	Till	23rd
					20.78	18.20	17.63	16.92	16.55	16.30	16.46	Till	22nd
					18.14	15.41	14.75	14.02	13.73	13.59	13.61	Till	22nd
	15.51	17.21	19.11	20.83	17.61	14.94	14.34	13.66	13.39	13.26	13.45	15.03	15.09
Lake St. Peter.....					16.23	13.58	12.85	12.60	11.75	11.75	11.86	Till	19th
St. Lawrence River..		From	16th	17.05	15.77	12.97	12.25	11.38	11.13	11.21	11.34	Till	18th
					12.64	10.34	9.67	8.90	8.71	8.82	8.91	Till	18th
					9.91	7.96	7.39	6.79	6.75	6.63	6.67	Till	18th
					4.01	3.15	2.68	2.46	2.85	Till	10th		

"A" -- Records taken by Toronto Harbour Commission. Elevations are above Mean Sea Level.

FINANCIAL STATEMENT

Total revenue of the Department of the Naval Service for the fiscal year ended March 31, 1921.. . . .	\$ 154,730 81
Demobilization refunds, previous years.. . . .	299,546 54
Total.. . . .	\$ 454,277 35
Net expenditure for the year on departmental appropriations.. . . .	\$3,891,697 05
Value of work done and materials supplied for account of other Canadian Government departments, British Admiralty and Foreign Governments.. . . .	1,883,332 61
Gross disbursements for the year.. . . .	\$5,775,029 66

The attached financial statements show expenditure under the financial appropriations, and also give details of revenue and expenditure.

DEPARTMENT OF THE NAVAL SERVICE

STATEMENT OF REVENUE FOR FISCAL YEAR ENDED MARCH 31, 1921

Royal Naval College—College fees.. . . .	\$ 4,500 00
Casual revenue.. . . .	79,251 88
Wireless apparatus licenses.. . . .	896 00
Wireless operators' examination fees.. . . .	418 40
Premium, discount, and exchange.. . . .	1,092 40
Miscellaneous revenue.. . . .	1,158 71
Radiotelegraph service—	
Alert Bay.. . . .	\$ 9,230 72
Cape Lazo.. . . .	759 82
Dead Tree Point.. . . .	2,324 78
Digby Island.. . . .	8,665 88
Estevan Point.. . . .	3,850 66
Gonzales Hill.. . . .	6,306 92
Ikeda Head.. . . .	248 46
Pachena Point.. . . .	91 33
Point Grey.. . . .	11,100 43
Triangle Island.. . . .	7,887 62
F.P.S. Stadacona.. . . .	0 88
" Cirenchy.. . . .	2 40
" Thiepral.. . . .	0 54
Camperdown.. . . .	56 46
North Sydney.. . . .	163 74
Sable Island.. . . .	93 00
Barrington Passage.. . . .	13,328 12
*Magdalen Islands (Grindstone).. . . .	2,953 35
*Kingston.. . . .	6 03
*Midland.. . . .	36 75
*Point Edward.. . . .	40 20
*Port Arthur.. . . .	40 58
*Port Burwell.. . . .	28 79
*Sault Ste. Marie.. . . .	148 13
*Tobermory.. . . .	13 35
*Toronto.. . . .	34 48
	\$154,730 81
Demobilization (previous year).. . . .	299,546 54
	\$454,277 35

*Revenue for past 3 years.

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SUSPENSE ACCOUNTS

SHOWING value of work done and material supplied for account of other Canadian Government departments, British Admiralty and Foreign Governments.

	Dr.	Cr.	Balance Transferred to 1921-22.
	\$ cts	\$ cts	\$ cts.
British Admiralty	500,456 23	281,303 96	219,152 27
British Admiralty Naval Prize Fund.....	125,520 05		125,520 05
British Ministry of Shipping.....	210,834 63	189,138 73	21,695 90
Air Board.....	39,488 43	29,811 21	9,677 22
Department of Marine and Fisheries....	57,313 86	40,921 60	16,392 26
Department of Customs.....	21,778 84	21,286 17	492 67
Department of Militia and Defence.....	22,323 84	18,779 41	3,544 43
Royal Canadian Mounted Police.....	1,597 06	651 29	945 77
French Government.....	3,170 29	755 47	2,414 82
Canadian Government Merchant Marine Limited...	3,249 12	2,348 38	900 74
Department of Interior.....	11,663 96	8,345 27	3,318 69
Department of Public Works	1,382 45	1,320 28	62 17
Miscellaneous	877,234 98	840,990 16	36,244 82
Allotments (Balance).....	5,433 00		5,433 00
Sundry Advances (Balance).	1,885 87		1,885 87
	1,883,332 61	1,435,651 93	447,680 68

STATEMENT OF APPROPRIATION ACCOUNTS FOR FISCAL YEAR 1920-21

	Appropriation.	Expenditure.	Balance Unexpended
	\$ cts.	\$ cts.	\$ cts.
Naval Service.....	2,000,000 00	1,999,362 42	637 58
Fisheries Protection Service.....	420,000 00	419,950 24	49 76
Hydrographic Surveys.....	315,000 00	314,984 06	15 94
Radiotelegraph Service.....	495,000 00	385,835 81	109,164 19
Tidal Service.....	30,000 00	30,000 00	
Patrol Northern Waters of Canada.....	15,000 00	15,000 00	
Customs Dues.....	500 00	87 26	412 74
Demobilization.....	240,000 00	239,329 46	670 54
Pay of temporary officers and clerks.....	60,000 00	60,005 49	*5 49
	3,575,500 00	3,464,554 74	110,945 26

*Grant exceeded.

Civil Government salaries.....	272,340 00	218,619 23	53,720 77
Contingencies.....	50,000 00	46,225 79	3,774 21

RECAPITULATION.

Naval Service.....	3,575,500 00	3,464,554 74	110,945 26
Civil Government.....	272,340 00	218,619 23	53,720 77
Contingencies.....	50,000 00	46,225 79	3,774 21
	3,897,840 00	3,729,399 76	168,440 24
Imperial Government (Special Account)—			
Disbursements.....	\$836,810 91		
Less:			
Reimbursements.....	\$470,442 69		
Transferred to 1921-22.....	366,368 22		
	\$836,810 91		
Unforeseen expenses		1,092 24	
Provisional Bonus Allowance Vote 363.....		117,767 88	
Re-Classification Vote 558		43,437 17	
		3,891,697 05	

STATEMENT of Expenditure under the Naval Appropriation for the Fiscal Year Ended March 31, 1921.

Ship or Establishment.	Pay and Allowances.	Stores and Allowances.	Medical Services.	Boys Training and Recruiting.	Repairs and Maintenance.	Works, Lands, Buildings.	Miscellaneous Effective Services.	Non-Effective Pay.	Total.	Grand Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.
H.M.C.S. <i>Aurora</i>	147,645 81	172,002 64	557 41	3,726 69	2,157 28		18,206 05		344,275 88	
“ “ fuel.....		176,664 05							176,664 05	
“ “ alterations.....					77,897 51				77,897 51	598,837 44
“ <i>Patriot</i>	40,354 36	39,284 51	94 75	6 49	1,163 08		1,379 69		82,282 88	
“ “ fuel.....		71,720 27							71,720 27	
“ “ alterations.....					51,030 52				51,030 52	205,033 67
“ <i>Patrician</i>	35,912 25	43,350 51	54 25		3,608 58		1,244 82		84,200 41	
“ “ fuel.....		67,866 09							67,866 09	
“ “ alterations.....					46,282 53				46,282 53	
Royal Naval College.....	114,041 95	35,588 75	4,315 37	368 62	3,564 14		31,431 32	3,939 56	198,349 03	
Headquarters.....	36,997 54	6,545 73	121 50	261 08			14,878 81	1,727 01	196,249 71	
Submarines <i>C.H. 14</i> and <i>C.H. 15</i> and <i>Depot</i>	20,089 00	20,388 88	134 50		28,221 22		8,933 70		60,531 67	
H.M.C.S. <i>Guclph</i> Depot.....	36,320 04	29,371 72	210 50	197 49	2,021 89		4,046 82	6,763 39	77,770 30	
H.M.C.S. <i>Naden</i> Depot.....	4,213 05	(Credit 89 46)	121 26	9 60	160 00	Martial Law 91 50)	3,052 53	145 95	78,931 85	
									7,701 43	
C.G.S. <i>Hochelaga</i>	4,185 34	9,385 25	16 00				407 11	1,038 12	15,031 82	
General account.....		41,061 60	76 00	943 20			13,840 78	280 00	56,201 58	
Halifax Dockyard.....						2,608 96			2,608 96	
Stores.....		137,019 98							137,019 98	
Supply Base Dr. operating expenses.		89,256 09			45,229 54		5,248 12	590 70	140,324 45	
Cr. Percentages.....		(Credit 52,762 66)							(Credit 52,762 66)	
Repair Base—Dr. operating expenses			1 35		104,216 55		5,864 15	804 51	110,886 50	
Cr. Percentages.....					(Credit 71,873 84)				(Credit 71,873 84)	
Fleet General.....		1,594 00			26,147 75		3,169 47	590 70	39,012 72	
Armament Supply Depot.....	313 25	18,811 42			7,788 93		2,027 78		31,501 92	
Torpedo Depot.....		397 20			420 41		1 05		28,941 38	
Esquimalt Dockyard.....	1,694 35	96,679 30			57,717 90		4,996 82	375 92	818 66	
Cr. Percentages.....		(Credit 11,558 85)			(Credit 6,949 70)				142,955 74	

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7. STORES

The activities of the Stores Branch during the past year have been similar in most respects to those of the preceding years immediately following the war. Summarized briefly, the main activities consisted in the purchase and supply of stores for the vessels of the naval and auxiliary services, the disposal of surplus war stocks and of ships no longer required under present conditions, as well as the reorganization of the branch as a whole, both as regards personnel and methods of procedure.

Early in May, 1920, reorganization of the branch to a peace basis was drawn up. This could not be made immediately effective on account of large quantities of naval stores still in process of return from the various naval ships and establishments being paid off at that time. In the public interest it was highly essential that the routine work of surveying, checking, cleaning, etc., of these stores should be satisfactorily completed before the staffs concerned were finally disbanded. However, a systematized gradual diminution of civilian staffs was put into operation until the number of employees was finally reduced to the normal authorized staffs.

Ships surplus to the requirements of H.M. Canadian Naval Service have been disposed of as rapidly as markets could be found. Seventeen vessels of sorts (including motor boats) were sold for an aggregate of \$223,848. All sales were duly advertised in the public press and the fullest opportunity afforded for every interested person to inspect the vessels. The highest quotations were accepted in all cases.

In connection with ships belonging to the Admiralty which remained in Canadian waters after conclusion of the war, successful arrangements were made during the present year for the disposal of ten trawlers and 26 drifters. The value of the vessels sold in this connection amounts to more than three quarters of a million dollars. In addition, forty-six other trawlers and forty-nine drifters were outfitted and turned over to a representative of the Admiralty at Halifax, N.S.

The cruiser *Aurora* and torpedo-boat destroyers *Patriot* and *Patrician*, having arrived at Halifax, N.S., on December 21, 1920, have been furnished with stores in all departments. A system of centralized storekeeping has been introduced in the former ship which, it was anticipated, will effect considerable economy. The system has been applied in the British and United States navies with excellent results.

Besides these three vessels, service has been rendered to eighty-five ships and establishments of the Royal Canadian Naval Service, including small craft, and seven Imperial ships and establishments other than trawlers and drifters. Also to sixty-five miscellaneous branches of other departments of the Canadian Government. Included in the former category are the auxiliary services connected with the Department of the Naval Service, such as the Fisheries Protection Service, the Hydrographic Surveys Branch, the Radiotelegraph Service and the Tidal and Current Surveys Branch. The latter category comprises the Departments of Marine and Fisheries, R.C.M. Police, Customs, Public Works, Militia and Defence, Public Health, etc., at various agencies or branches. Occasional service was also rendered to the Navy League of Canada, the Canadian Government Merchant Marine Service, the Canadian Pacific Ocean Services, etc., etc.

Included in the ships and establishments of the Imperial Government to whom service has been given are the Royal Victualling Yards at Kowloon (Hong Kong) and Bermuda, to whom large supplies have been issued and for whom contracts have been placed and purchases made in Canada to a considerable extent. There were also supplies furnished to the Admiralty for Imperial trawlers and drifters sold or sent to England aggregating nearly \$400,000.

Efforts to dispose of all surplus stocks have been continued. During the fiscal year naval and victualling stores, aggregating nearly \$91,000, have been disposed of out of the estimated surpluses, and the moneys collected credited to casual revenue.

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In addition, sales by auction of unserviceable stores have been carried out at both dockyards which realized approximately \$27,000. Considerable quantities of stores of all sections, especially clothing, have also been supplied to other Departments of the Canadian Government.

Stocks of naval and victualling stores were maintained to a value of approximately \$3,567,000. The value of store transactions under these divisions at H.M.C. dockyards for the year were: Receipts (returns of stores from ships and establishments on demobilization, etc., and articles obtained by purchase), \$661,000; issues, \$893,000. Except for armament stores and lubricating oils, practically all stores belonging to the Admiralty have now been disposed of, either by issue to H.M. ships or by sales as requested by My Lords Commissioners of the Admiralty. Reserve stocks of fuel oil as required by H.M.C. ships are maintained at Halifax, N.S., and Vancouver, B.C.

Arrangements have been completed for the British Government to provide the required reserves of ammunition and other armament stores for H.M. Canadian ships and establishments in common with those for H.M. ships on the North Atlantic and Pacific stations, the care and issue of which will be at the responsibility of this department. This is of considerable importance in that Canadian reserve requirements roughly approximate \$1,500,000, about one-third of which is of an explosive nature and continuously and unavoidably deteriorating, sometimes very rapidly, and liable to become a total loss at any time when the prescribed periodical tests denote that destruction is necessary in the public safety. In future such deterioration will be charged against Canada only on explosives, etc., actually carried on board H.M. Canadian ships. The value of armament stores still remaining on Canadian charge is \$420,000, the value of Imperial Government stocks in the custody of this department is approximately \$600,000.

The purchasing work of the branch has consisted principally in providing miscellaneous minor articles where the requirements of H.M. Canadian naval and auxiliary ships and establishments could not be met out of existing stocks. Consequently the number of purchases were relatively greater to the monetary value involved than during any other year of the department. Practically the only exception was the provision of reserve stocks of fuel oil for the new fleet. The total value of purchases consummated was \$1,103,965.37, which was divided amongst the different classes or sections of stores as follows: Provisions, \$247,129.94; clothing, \$11,854.25; medical stores, \$367.56; fuel oil and coals, \$536,773.69; and naval stores, \$307,839.93. The last-named section comprises timber, metals and metal stores, textiles, electrical stores, scientific, navigation and meteorological instruments; paints, lubricating oils; packings, and miscellaneous articles of ships' equipment in all departments. It is observed that a considerable percentage of these purchases were made on behalf of the British Government, from whom reimbursement is being obtained in the usual course.

Standing contracts for fresh provisions, etc., have been maintained at all ports of call for vessels of the naval and auxiliary services. These include fresh vegetables, fresh and frozen meats and fish, bacon and lard, butter, bread and ice, and other miscellaneous perishables; laundry work; fresh water; bunker coals; making up uniforms, etc. At Atlantic and Pacific ports these contracts may be taken advantage of by visiting British warships if they so desire, purchases thereunder being made direct by the ships concerned. This has proven itself a satisfactory and economical system of obtaining these items.

The system of general messing whereby the complements of vessels of the naval and auxiliary services are victualled by the department direct has been continued with very satisfactory results. A thorough audit of the store accounts involved as well as of accounts of all other supplies is conducted in the branch, as a check on the efficient and economical handling and use of the various stores used.

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8. RADIOTELEGRAPH BRANCH

The work of the Radiotelegraph Branch comprises the design, construction and operation of stations on the East coast, Great Lakes, Hudson bay and West coast; the licensing of all private radio stations in Canada and on Canadian ships; the inspection of all licensed stations in Canada and ships plying to Canadian ports to see that they are complying with the International and Canadian regulations and in the case of ships to see that they comply with the section of the Radiotelegraph Act which calls for the compulsory equipment on certain classes of passenger vessels irrespective of nationality carrying Canadian passengers; the examination of all commercial and amateur operators for certificates of proficiency in radiotelegraphy and the administration of the Radiotelegraph Act.

The primary object of the Government Radiotelegraph Service is to provide facilities for communication with ships at sea and thus assist in their navigation and the safeguarding of the lives of the people they carry; it also provides means of communication with points not reached by existing land telegraph. The service also undertake the handling of commercial messages with ships, commercial interstation communication between its stations, direct commercial service to Bermuda together with the auditing, rendering and collection of all accounts for same, also the auditing, rendering and collection of accounts to various operating companies and foreign administrations for radiotelegrams exchanged by foreign ships through Canadian coast stations and by ships of Canadian registry through foreign coast stations.

All land stations are inspected at least once a year and all ships whenever they are in port. For this purpose inspectors and staffs are maintained at Ottawa, Montreal (summer), St. John (winter), Halifax and Victoria, B.C. Examinations of operators are held at the above points and at other centres when a reasonable number of candidates can be gathered together. The total number of stations in operation in the Dominion and on ships registered therein during the year was 904.

With the exception of the small station at Pictou, N.S., all of the forty-seven coast stations (forty-three coast and four D/F) in the Dominion (that is stations communicating with ships at sea) are owned by the Government. These on the Pacific coast, Hudson bay, Barrington Passage, N.S. Halifax Dockyard and the four Direction Finding stations on the East coast, eighteen in all, are operated directly by the Department of the Naval Service. The stations on the Great Lakes and the remaining stations on the East coast, thirty in all, which work on a wavelength of 600 metres, whilst owned by the Government, are operated under contract by the Marconi Wireless Telegraph Company of Canada, Limited.

The Government owned and operated station at Barrington Passage, N.S., continues to provide a commercial service with Bermuda on a wavelength of 4,200 metres C.W. and a long-distance commercial service with ships at sea. This station maintains continuous watch on 2,200 metres C.W. except during commercial traffic routines with Bermuda at 12.30, 4.30 and 8.30 a.m. and p.m. G.M.T. and during H.M. ship watch routines on 2,400 metres for fifteen minutes commencing 0345 G.M.T. and every subsequent four hours. Barrington also transmits weather forecasts on 1,600 metres spark at 1.30 and 13.30 G.M.T.

Pacific Coast.—The work of dividing the coast station service operated by the Government on the Pacific coast into two groups, one to handle ship to shore business and the other inter-station or ordinary telegraph business, is proceeding satisfactorily. Under this scheme the Ikeda head station was closed on the 15th September, 1920, and the Pachena Point station temporarily closed on the 23rd October, 1920. Construction work on the Bull Harbour station, to replace the existing station at Triangle Island was commenced in January, 1921. Considerable work was done before the close of the fiscal year and it is expected that all work will be completed and

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the new station placed in commission at an early date. Construction work in connection with the increased power at the Estevan station to provide adequate facilities for communication with transpacific ships has been commenced and is proceeding satisfactorily. The installation of an arc equipment at the Alert Bay station was completed and is now in successful operation. Improved valve receiving equipment has been installed in all stations and special receiving aerials have been introduced at several stations with an appreciable increase in efficiency of reception.

Direction-Finding Stations.—A new direction-finding station was erected at Red Head, St. John, N.B., and was officially placed in commission on the 1st March, 1921. This station fully covers navigation in the Bay of Fundy. The department continues to receive very encouraging reports from mariners of results obtained from all four direction-finding stations on the east coast. During the past year the four stations gave out 5,352 bearings. The establishment of a direction-finding station on the west coast is still under consideration.

During the past year 483 operators were examined for certificates of proficiency in radiotelegraphy and 172 certificates have been issued to date. There were 581 amateur radiotelegraph stations licensed in the Dominion during the year. Under the regulations, the maximum power an amateur may use is one-half K.W., the wavelength varying with the distance between the licensed station and any commercial coast or land station or a route of navigation, viz:—

Within 5 miles.. . . .	50 metres
Between 5 and 25 miles.. . . .	100 "
Between 25 and 75 miles.. . . .	150 "
More than 75 miles.. . . .	200 "

The total number of radiotelegraph stations in operation in the Dominion and on ships registered therein is as follows:—

Coast stations.. . . .	43
Government Land stations.. . . .	1
Direction Finding stations.. . . .	4
Government Ship stations.. . . .	46
Licensed Ship stations.. . . .	181
Licensed Public Commercial stations.. . . .	6
Licensed Private Commercial stations.. . . .	12
Licensed Radiotelegraph training schools.. . . .	18
Licensed Experimental stations.. . . .	11
Licensed Amateur Experimental stations.. . . .	581
Licensed Limited Coast stations.. . . .	1
Total.. . . .	904

Operation of the Coast Station Service.—The total number of messages and words handled during the year is as follows:—

	Messages	Words
East Coast.. . . .	295,413	3,766,863
Great Lakes.. . . .	24,339	398,234
West Coast.. . . .	185,191	3,069,116
Hudson Bay.. . . .	Nil	Nil

The amount of business handled by the East Coast system shows an increase from last year's business amounting to 58,205 messages, containing 996,042 words. The Great Lakes system (operated by the Marconi Wireless Telegraph Company of Canada, Limited, under contract) shows an increase of 4,182 messages with an increase of 28,313 words. The West Coast system (operated directly by this department) shows an increase of 11,223 messages with an increase of 170,968 words.

The Hudson Bay system was not in operation during the year.

Revenue.—The total revenue collected during the year amounted to \$64,978.61, as against \$51,464.68 in 1919-20.

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Examination for Certificate of Proficiency.—483 operators were examined during the year, including 218 re-examinations. 291 candidates were successful and 192 failed.

Assistance rendered to Ships.—Assistance was rendered by the Government Radiotelegraph Service during the year to the following vessels in distress:—

WEST COAST

SS. <i>Prince John</i>	Motor ship <i>Pacific</i>
U.S. schooner <i>Louise</i>	U.S. schooner <i>Evolution</i>
SS. <i>James Caird</i>	SS. <i>Princess Beatrice</i>

EAST COAST AND GREAT LAKES

SS. <i>Zaca</i>	SS. <i>Canadian Voyager</i>
" <i>Montana</i>	" <i>Chicago City</i>
" <i>Clare Hugo Stinnes</i>	" <i>Ontanedo</i>
" <i>Bombardier</i>	" <i>Victorieux</i>
" <i>Grelarine</i>	" <i>Baltic</i>
" <i>Manitoba</i>	" <i>Frances Wilder</i>
" <i>Schoolcraft</i>	" <i>Romsdalifjord</i>
" <i>T. E. Morse</i>	" <i>Etna</i>
" <i>West Pocasset</i>	" <i>Mystic</i>
" <i>Lake Elcin</i>	" <i>Willdomino</i>
" <i>Bristol City</i>	" <i>Portia</i>
" <i>Fresno</i>	" <i>Basaan</i>
" <i>City of Colombo</i>	

Direction Finding Stations, East Coast.—The Direction Finding stations continue to render valuable assistance to navigators. The following is a summary of bearings given to ships by the few stations on the East coast during the past year:—

Station	Single Bearings	Cross Bearings		Total
		2 Stations	3 Stations	
Chebucto Head.. . . .	938	521	10	1,469
Canso.. . . .	1,020	385	13	1,418
Cape Race.. . . .	2,236	72	10	2,318
St. John.. . . .	147	147
	4,341	978	33	5,352

NEW CONSTRUCTION, ADDITIONS AND ALTERATIONS

WEST COAST

Dingle Island.—A detector and two-step amplifier were installed which greatly helped in the reception of weak signals. Possible sites for a station in Prince Rupert were visited.

Daniel Tree Point.—Receiving tests were carried out with the Point Grey station, the latter using arc equipment.

Estevan Point.—A two-step amplifier was installed. Sites were selected for the new power-house and bungalows. Contracts for all material have been placed and the new construction work has been commenced.

Pachena.—This station was temporarily closed on October 23, 1920, and left in the hands of a caretaker pending the opening of the new station at Estevan.

Alert Bay.—Receiving tests were carried out with valve detectors and amplifiers. Repairs were made to the track and buildings. A 10-horse-power gasoline engine and arc equipment were installed and tests carried out with Point Grey, with satisfactory results.

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Point Grey.—Receiving and transmitting tests were made on C.W. with amplifiers and loop aerial with Alert bay, Dead Tree point, Digby island and Bull harbour.

Bull Harbour.—A site was chosen for a new station at Bull harbour, Hope island, to replace the existing station at Triangle island which, owing to its extreme isolation, has always been a very difficult station to maintain. The site, which consists of twenty-three acres of land, was secured from the Indian Department and is considered desirable in every way. Construction has been commenced and the new station will be placed in commission early in the next fiscal year.

Ikeda.—This station was closed and dismantled on the 15th September, 1920. The buildings were practically moved to Bull harbour and there used as construction bunk-houses. All of the gear and what remained of the dwelling-house equipment was shipped to Esquimalt for storage.

EAST COAST

Chebucto Head D.F.—A one and a half story bungalow was built to provide accommodation for the officer in charge and family. The masts and rigging were overhauled and put in first-class condition.

Canso D.F.—Additional storage space for coal was obtained by excavating a large room under the station building. The station buildings were repainted.

Cape Race D.F.—Alterations were made to make connections at back of main switchboard easily accessible. A hot wire ammeter was installed.

St. John, N.B. D.F.—A decision was made to establish a direction finding station in the vicinity of St. John, N.B., as an aid to navigation to vessels making that port. After exhaustive preliminary tests to determine suitability of available possible sites a site was finally selected at Red Head, on the eastern side of the harbour. This site comprising approximately five acres of land, together with a dwelling-house and barn, was purchased from Oliver Gibson for the sum of \$5,000. A standard D.F. station operating house was erected together with 130 ft. mast, with the necessary jury masts for the Bellini-Tesi system of direction finding. This station is complete with all up-to-date receiving equipment and spark transmitting equipment. The station was officially placed in commission on the 1st March, 1921, and has since rendered valuable assistance to shipping.

PERSONNEL

	Government				Commercial.			
	Head-quar- ters.	Coast Sta- tions.	Land Sta- tions.	Ship Sta- tions.	Head-quar- ters.	Coast Sta- tions.	Land Sta- tions.	Ship Sta- tions.
Engineers and officers in charge..	4	15	7	10	10	30	8	200
Operators.....		45	5			65	17	9
Other employees.....	13	7	17		38	5	22
Executive officials and inspectors...	4		7		8	5
	21	67	36	10	56	105	47	209

Total Personnel—551.

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9. GENERAL

The reorganization of the Naval Department on a peace basis became effective on the 15th May, 1920. Officers, men and civilian employees entered for war service were discharged and the various branches, which were expanded to meet war conditions, were reduced to their pre-war status.

The Fisheries Branch and Life Saving Service, which were placed under the administration of the Naval Department in 1914, were transferred to the Department of Marine and Fisheries, this transfer to date from July 1, 1920. Officials and employees of the department have rendered excellent service throughout the year.

I have the honour to be sir,

Your obedient servant,

G. J. DESBARATS,
Deputy Minister.

10. "SEICHES OF LAKE SUPERIOR"

(By CHAS. PRICE)

Seiches, or oscillations of the water levels of the Great Lakes, are of common occurrence, and can easily be registered on an automatic gauge of the graphic type.

The automatic gauges maintained by the Canadian Hydrographic Survey are situated at Port Arthur and Michipicoten harbour, on lake Superior, and above the lock at Sault Ste. Marie, on the St. Mary's river. These gauges are of the Haskell type and, because of the large scale, allow an excellent opportunity to study the different seiche actions at these points. These three gauges all show a continual oscillation of the lake surface outside of wave action which is eliminated from the float chamber by using a small intake.

The first report of anything in the nature of a seiche on lake Superior, seems to be in the following paragraph, which is taken from Alexander Mackenzie's Voyages.

"A very curious phenomenon was observed some years ago at the Grande portage, for which no obvious cause could be assigned. The water withdrew with great precipitation, leaving the ground dry that had never before been visible, the fall being equal to four perpendicular feet, and rushing back with great velocity above the common mark. It continued thus falling and rising for several hours, gradually decreasing till it stopped at its usual height. There is frequently an irregular influx and deflux, which does not exceed ten inches, and is attributed to the wind."

A slightly larger seiche, than that reported by Alexander Mackenzie occurred above the lock, at Sault Ste. Marie, on the St. Mary's river on June 10, 1920. The gauge records at this time at Sault Ste. Marie and at Port Arthur have been reduced and are shown on the accompanying profile.

The meteorological report for lake Superior was: June 10, "Barometer 30.00, light to moderate variable winds"; June 11, "Barometer 29.90, moderate to fresh easterly winds." Therefore there was neither undue barometric pressure nor heavy winds to which the sudden variation at Sault Ste. Marie can be attributed.

The daily mean water surface elevation, by hourly readings, at Sault Ste. Marie, was on June 10, 601.98, and on June 11, 601.86. These elevations are above mean sea-level and are referred to the United States Lake Survey datum of 1903 adjustment.

The water at Sault Ste. Marie first rose 1.48 feet then in exactly two hours fell 4.18 feet, and again rose 4.44 feet in one hour and forty-five minutes; then three

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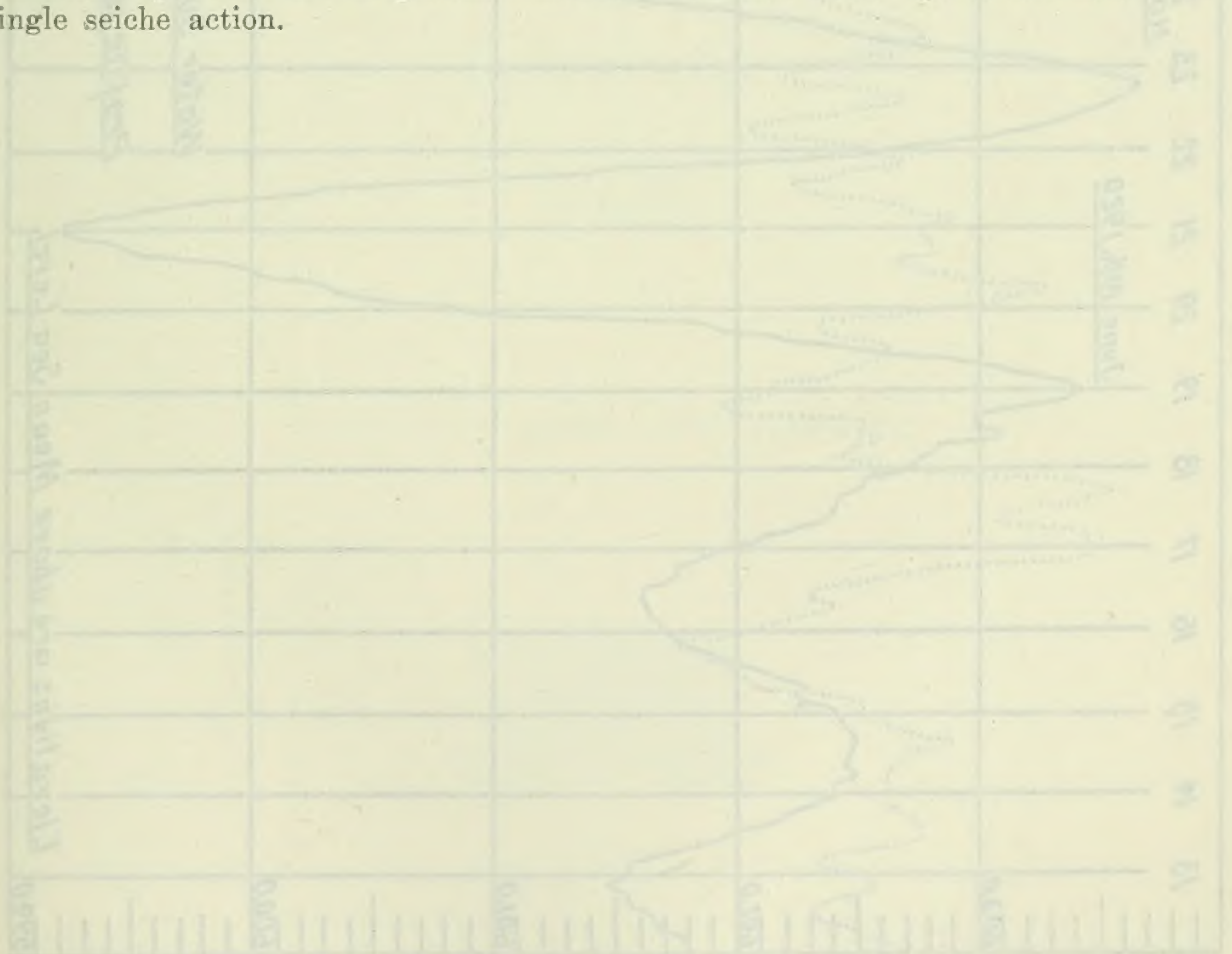
smaller seiches occurred at fairly regular intervals of three hours, for a rise and fall of about 1.75 feet. After the three regular seiches the water surfaces gradually returned to its usual seiche action of, from a few inches to a foot at irregular intervals.

Seiches, above the lock, at Sault Ste. Marie, are carried down from lake Superior, and the vertical variation is increased by contraction into the narrowness of the St. Mary's river. The compensation works, for the control of lake Superior, are a short way below the automatic gauge site, and also are an aid in increasing the vertical variation of seiches, above the range formerly recorded at this point. The amount of increased variation caused by the compensation works would vary according to the number of sluice gates being open or closed at the time a seiche occurs.

The quickest acting seiche, recorded by this survey, was at Michipicoten Harbour on August 27, 1917. With a strong southwest wind the seiches gradually increased, in five hours from a range of a few inches, till a seiche occurred in which the water level fell 1.00 foot in ten minutes, then rose 2.56 feet in nine minutes, after which it again fell 1.84 feet in eight minutes, and continued a series of rapidly occurring seiches, with a range of from six inches to a foot, for fourteen hours, before the lake surface oscillations again became normal.

During storms the wind action on the lake causes the surface water to pile on to the lee shore faster than the undercurrents can carry it back to the weather shore. This causes a gradual rise above normal level on the lee shore, during which sudden seiches, caused by varying strengths of the wind, occur. During calm weather, gradual seiches occur and the only cause to which they can be attributed is varying barometric pressure on different parts of the lake surface.

Records, of lake Superior water surface obtained by this survey during the past ten years, would indicate: that seiches caused by winds are of sudden variations and seldom last over ten to twenty minutes for a single seiche; that seiches caused by barometric pressure are of gradual variation and take from one to five hours for a single seiche action.



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